DOCUMENT RESUME

ED 229 909 EC 151 906

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TITLE A Justification for the Use of Computer Assisted Instruction with the Physically Handicapped.
PUB DATE Mar 83
NOTE 17p.; Paper presented at the Council for Exceptional Children's National Conference on the Use of Microcomputers in Special Education (Hartford, CT, March 10-12, 1983).
PUB TYPE Guides - Non-Classroom Use (055) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Communication Aids (for Disabled); *Computer Assisted Instruction; Computers; Educational Methods; Elementary Secondary Education; Individualized Instruction; *Physical Disabilities

ABSTRACT

The paper reviews the beginnings of computer assisted instruction (CAI), notes the advantages of CAI over traditional instruction, and considers its most positive features when teaching children with physical handicaps. Among positive features of CAI are improved student attitudes toward CAI, equivalent retention rate, reduced paper work for instructors, and the savings in students' time spent learning an individual task. Studies on the specific advantages of CAI for physically handicapped students are reviewed. Among uses discussed are as communication aids, calculation helps, and as avenues for interacting more normally with the environment. (CL)

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ED229909

A JUSTIFICATION FOR THE USE OF COMPUTER ASSISTED INSTRUCTION WITH THE PHYSICALLY HANDICAPPED

A Paper Presented to the
CEC National Conference on the
Use of Microcomputers in
Special Education
March, 1983

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EC151906

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With the passage of Public Law 94-142 in 1975, public school systems were required to provide each child in the United States with an education appropriate to his or her individual needs. Specifically, this law demanded a unique curriculum, an Individual Educational Plan (IEP), specifically written for each handicapped child, while, at the same time, requiring that he be placed in the "least restrictive environment", an educational setting where, as much as possible, the physically handicapped student would be allowed to interact with his non-handicapped peers. To encourage this, Section 604 of the law provided for the use of technical aids and devices.

The financial implications of this law have been considerable for larger school systems, and almost insurmountable for smaller systems, both of which have had to hire special educators, adapt curricula, and initiate extensive record keeping activities. Education of the PH is extremely time consuming, both on the part of the teacher, and of the student. Teachers find themselves constantly waiting for feed-back from non-oral students. This interaction, whether hand-written or displayed in some other fashion (e.g.: type-writing, alphabet lap board, Bliss symbol board) can extend communication time, and, as a result, learning time, to the point of frustration, both for teachers and students. Geoffrion

and Bergeron (1977) described the problem as follows:

> Perhaps the most universal characteristic shared by handicapped individuals is the inability to communicate effectively through conventional symbol systems. Various handicaps differ as to the locus of the communicaton breakdown, but once broken, the results of a lack of communication are very similar across handicaps.

The authors continued by indicating that the greatest visible effect was a failure on the part of the handicapped individual to learn the symbol system used by "normal" people. This is has frequently been accompanied by loss of interest in any activity which involves communication and interaction.

Gearheart and Weisman (1976, pp. 83; 85) felt that adapted educational materials should be provided so that cerebral palsied students have every opportunity to survive in a regular class-room. They cautioned teachers by saying:

> It may take him considerably longer than the other (normal) students to complete an assignment because of the motor involvement, but he must be allowed to complete it independently.

Meyen (1982, p. 395) stated that, "because of the varied educational needs of the physically disabled, curricula must integrate adaptive techniques with a variety of educational materials." The author continued by saying that emphasis should be on the creation of new, and the adaptation of existing materials to meet individual needs. It must be remembered that, while on one hand, the damage which has produced the physical abnormality may also produce a mental deficiency, it is also quite possible that physical disabilities are not accompanied by mental deficienecy (Schwartz, 1975, p. 41).

To summarize, since the passage of PL 94-142 in June, 1975, many educators have been confronted with an almost monumental task -- that of educating a child with special needs, typically in a class-room designed for "normal" students. While these special needs are not impossible to deal with, they generally require a disproportionately large amount of time, both on the part of the teacher, and the student. Generally, the handicapped student takes longer to communicate, takes longer to learn, and requires specially designed instructional materials. All of this represents teacher time which, to administrators, means money. As indicated above, however, this law also encouraged the use of technical aids and devices. Technical aid in the form of computer assisted instruction may be a very viable solution to the problems inherent in educating the physically handicapped.

Computer-assisted-instruction (CAI) came into existance in the early 1960's, probably due to the increasing general availability of main-frame computers, and to the programmed instruction movement, which saw CAI as the perfect medium in which to manifest Pressey's teaching machine, and Skinner's reinforcement learning principles (Gleason, 1981; Dence, 1980; Burns & Bozeman, 1981; Grinstein & Yarmish, 1981; Steinberg, 1977). With the birth of CAI came CAI research, with a majority of projects being carried out by the universities and business interests which could afford the abundant main frame computer resources necessary for CAI at that time. By the early 1970's,

however, larger public school systems had become computerized, resulting in increased CAI studies at the primary and secondary levels (Jamison, Suppes and Wells, 1974). With the commercial availability of the first microcomputers in 1976 came an alternative to the expensive, and frequently temperamental main-frame computers, which added impetus to the CAI movement. At the present time, extremely cost effective microcomputer based educational systems can be had by almost any facility (Caldwell, 1980; McIsaac and Baker, 1981; Watts, 1981; Stevens, 1981; Daneliuk & Wright, 1981; Cavin, Cavin & Lagowski, 1980; Holmes, 1982; Mills & Stonier, 1982; Skyrme, 1982).

While a variety of seemingly beneficial instructional features are inherent to CAI (CAI is self paced, and provides immediate feed-back. It is adaptive, and highly interactive.) and are undebated, five facets of the effectiveness of CAI over that of traditional instructon (TI) have consistantly been considered in the literature: (a) Student achievement; (b) Student attitudes toward CAI and/or subject matter; (c) Student retention; (d) Cost; (e) Learning time. Each of these variables has been studied repeatedly, often with confusing and contradictory results. Burns and Bozeman (1981) described the resulting situation:

> Various researchers have attempted to narratively review the research literature in an attempt to formulate conclusions and/or to establish a more broadly based case for CAI. These endeavors ... have resulted in conflicting and inconclusive findings.

When used as the sole instructional medium, the effectiveness of CAI in terms of student achievement has not always been shown to be significantly better than TI (Dence, 1980; Edwards, Norton, Taylor, Weiss and VanDusseldorp, 1975; Vinsonhaler and Bass, 1972; Jamison et al, 1974). However, Holmes (1982), while admitting to the debatability of the CAI effectiveness question, indicated that a medium with the versatility of CAI seen only as effective as TI might still be advantageous in other areas:

> At the very least it must be admitted that a machine which can, when required, replace traditional instruction without deleterious effects on learning must surely be seen as an advantage for learners who have limited access to traditional modes of instruction, and perhaps those who do not respond well to those modes.

Herbert (1982) expressed similar sentiments. Reporting on a study which produced no significant differences between achievement levels of students in CAI and TI situations, he pointed out other observed benefits such as student paced instruction, reduction of paper work for instructors, and improved student attitudes. When used to supplement, rather than replace TI, evidence strongly supported the effectiveness of CAI (Vinsonhaler and Bass, 1972; Edwards et al, 1975; Chambers and Sprecher, 1980; Burns and Bozeman, 1981).

As pointed out by Clement (1981), student attitudes toward CAI have been found to be almost consistantly positive at all educational levels. Clement indicated that this was probably due to five attributes of CAI:

> (a) self-paced (b) lack of embarassment when mistakes are made (c) immediate feedback (d) a general feeling that they learn better through the computer system (e) lack of subjective evaluations; the computer bases its evaluations strictly on student performance, not on personal characteristics of a student....

Chambers and Sprecher (1980) in a literature review cited six references indicating improved student attitude toward the use of computers in learning. Dence (1980) in a review of seventeen studies found evidence that students having experienced CAI had more positive attitudes toward it (CAI) than those students without any CAI experence. Magidson (1977), Herbert (1982), Cavin et al (1980) and Holmes (1982) also mentioned positive student attitudes toward CAI and subject matter. Kulik, Kulik and Cohen (1980) in considering the eleven relevant studies in their meta-analysis of 59 studies found a "small" difference in favor of CAI in "course quality" as compared to TI. In the seven studies reviewing student attitudes towards subject matter an even smaller difference was reported, again in favor of CAI.

In terms of student retention Gleason (1981) stated that students taught via CAI had retention rates equivalent to, if not higher than those students taught by TI. Dence (1980) agreed with Gleason. Edwards et al (1975) in a review of literature mentioned that, in the three relavant studies, the reverse situation was evident: students taught by TI had higher retention rates than students taught with CAI.

The topic of cost has generally been considered in terms of the cost of microcomputer supported vs mini or main-frame computer supported CAI. Cavin et al (1980), Caldwell (1980),

and McIsaac and Baker (1981) pointed out that microcomputers were much more desirable for CAI than main-frame computers, and gave cost as a major factor. Chambers and Sprecher (1980) felt that the microcomputer had all of the capabilities of the mini-computer, plus color, graphics, and the potential for audio in- and out-put, but at a much lower cost. The smaller memory capacity of microcomputers was mentioned as a major disadvantage, however. The author continued by mentioning that, with mass production and improved technology, the cost of microcomputers was expected to quickly drop to the point of cost-effective uses of CAI.

It is in terms of reduced student learning time that CAI has its one seemingly indisputable benefit. An abundance of authors (Kulik et al, 1980; Kearsley, Hunter and Seidel, 1983; Chambers and Sprecher, 1980; Dence 1980; Lewellen, 1971; Magidson, 1977; Edwards et al, 1975; Gleason, 1981; Jamison et al, 1974; Burns and Bozeman, 1981) reported savings in students' time ranging in estimates from thirty to as high as fifty per-cent over that of TI.

Apparently, the effectiveness of CAI with non handicapped students has been, at least to some extent, delineated. Its benefits, when used as a supplemental form of instruction are well documented, as is its ability to reduce student learning time. The following authors have expressed their interest in using CAI specifically with the physically handicapped.

Thorkildsen and Williams (1981) who described special education as an extremely "labor intensive educational process" demanding a considerable amount of one-on-one, and small group interaction felt that CAI may prove itself an economically feasible solution to many problems caused by PL 94-142:

> (This law) should also have significant impact on the use of computers in special education settings. The fact that every child is now to receive an appropriate education means that the teaching resources in special education will be stretched to the limit. Labor saving devices will be very attractive. The low density of the population and the diverse nature of their handicaps, along with the goal of placing children in the least restrictive environment, will result in these children being placed in small numbers in regular classrooms. The schools will be required to provide appropriate education for a small number of children in widely scattered locations.

That this individualization and self-paced educational system demanded by the handicapped can be realized in CAI is further testified to by others. A variety of authors (Jamison, Suppes and Wells, 1974; Clement, 1981; Carman and Kosberg, 1982; Magidson, 1977; Lewellen, 1971) felt that CAI provided the most highly individualized interaction between curriculum and student of any instructional method currently available. Embarassment associated with the slow progress, and frequent mistakes commonly experienced by the physically handicapped while learning can be greatly reduced.

Hill (1976) indicated a belief in the computer as a solution to many of the needs of the physically handicapped for very basic reasons. Many of these students have graduated from pencils to typewriters due to the physical impossibilities associated with hand writing. Doing a math problem on a

typewriter has its frustrations also, however, when one considers that most mathematical computations move from right to left, and most typewriters move from left to right. Mistakes are also a problem. Computers, on the other hand, can be programmed to move from right to left, and computer erasures are made by pressing a key. If the student can type efficiently enough to make the mistake in the first place, he can erase with a similar effort.

Papert, in testamony to the House Sub-Committee on Science and Technology (1977) stated that even the most physically invloved person usually has some control over some muscle. Once that control has been identified, and in conjunction with appropriate electronic interface devices, it is generally a simple matter to program a microcomputer to respond to the movement, resulting in the formation of a channel of communications from human to computer. This linking of a handicapped individual to a computer more efficiently than simply having him use a head-stick on a keyboard enables a handicapped person to interact efficiently enough to become financially self-supporting. Papert termed use of a computer in this manner as an informational prosthesis.

Goldenberg (1979, p 5) described the potential for computer aids to the physically handicapped as follows:

> The computer provides flexible technology that can so thoroughly enrich the experiences and communication of certain handicapped persons that activities and learning that were previously thought impossible for them become routine and easy.

Goldenberg described the handicapped child as being at a decided disadvantage when he "must mediate interaction with the world through coordinated motor activity." The author pointed out, however, that, with the adaptable technology of the computer, the same student can learn to communicate quite adequately. In addition, handicapped students who are exposed to the immediate feedback and experiementation permitted with computers and appropriate software experience a "striking change" in their autonomy (Goldenberg, 1979, pp. 12; 24). To summarize, Goldenberg (1979, pp. 30-31) states:

> In my view, it is the child's abnormal experience of the world (e.g., his lack of easy, fluent communication and casual play) more than his abnormal behavior (e.g., his inability to speak, write or walk) that handicaps the child.

The computer can provide a more normal interface between the abnormal student and his environment.

Vanderheiden (1981) felt that microcomputers were essential to the proper education of the handicapped. He stated that the "manipulation and exploration important to development may be impossible" without them. Using microcomputers with specially devised and individualized electronic interface devices might provide a means of manipulating objects on a TV screen, or in real space. In addition, Vanderheiden pointed out a more direct educational need which can be met by use of CAI. Almost by definition, the handicapped experience a slow rate of coordinated meaningful physical activity. This necessitates extended time for most educational tasks. For example, in a

typical class room discussion, the handicapped student may know the correct answer, but conveying the answer to the instructor may often prove to be too time consuming for all involved. In addition, such common educational activities as diagramming sentences, working a set of practice math problems, or writing a paragraph would all be such monumental tasks that even the most dedicated handicapped student becomes frustrated. As Vanderheiden stated:

> Since the need to see, read and write, take notes, and do independent work are necessary capabilities for receiving an education within our current system, the severely physically handicapped individual who lacks them is at an extreme disadvantage.

Appropriate course ware coupled with the general tendency of CAI to reduce learning time have the combined potential to solve many problems experienced by both the physically handicapped in learning, and special educators in teaching.

It is apparent that, while many "benefits" of CAI are still being debated, this educational medium still has much to offer the teacher who is attempting to educate a special needs child. CAI can be relatively inexpensive when compared to its human counter-part, and it appears to be extremely effective in terms of student achievement. CAI is adaptable enough to meet the needs of even the most severely physically involved student, and it is infinitely patient. The major strength of CAI, however, that of reducing learning time, meshes precisely with the major weakness of the handicapped student: extended learning time.

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